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International Journal of Current Research
Vol. 8, Issue, 11, pp.41552-41555, November, 2016

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

ISSN: 0975-833X

RESEARCH ARTICLE

GROWTH, YIELD, QUALITY AND ECONOMICS OF CHRYSANTHEMUM AS INFLUENCED BY FOLIAR APPLICATION OF BIOSTIMULANTS UNDER NATURALLY VENTILATED POLYHOUSE

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ARTICLE INFO

Article History:
Received 18th August, 2016
Received in revised form
22nd September, 2016
Accepted 13th October, 2016
Published online 30th November, 2016

Key words:

Biostimulant, Biovita, Sea weed extract, Yield, Quality.

ABSTRACT

An experiment was conducted to know the influence of biostimulants on growth, yield, quality and economics of chrysanthemum under naturally ventilated polyhouse at department of Floriculture and Landscape Architecture, College of Horticulture, Mudigere during 2015-16. 12 biostimulant formulations in 2 different concentrations were used for the study. Among different biostimulant treatments application of Biovita @ 0.5% at 60, 90 and 120 DAP resulted significantly maximum plant height (66.83 cm), number of leaves (82.95), stem diameter (7.30 mm), number of flowers (92.15) flower yield per plant (424.09 g), flower yield per square meter (4.05 Kg), flower yield per hectare (40.50 t/ha), sucker yield per plant (9.85), individual flower weight, flower diameter, stalk length (46.89 cm, 5.06 g and 6.70 cm, respectively) vase life (22.5 days) and shelf life (11 days) with highest net returns and B:C ratio (₹ 3, 12, 411.07 and 4.43, respectively). Whereas, the lowest values for all the above parameters were recorded in control (RDF).

Citation: Pruthvi, P. Hegde, Hemla Naik, B. and Beeraligappa, 2016. "Growth, Yield, quality and economics of chrysanthemum as influenced by foliar application of biostimulants under naturally ventilated polyhouse", *International Journal of Current Research*, 8, (11), 41552-41555.

INTRODUCTION

Flowers and flowering plants have been a fascinating part of our life. Among them, chrysanthemum (*Dendranthema grandiflora* Tzvelev.) is one of the most interesting and oldest flower crops which belong to the family, Asteraceae. In Dutch cut flower auction, ranks second after rose. Important both as cut flower, loose flower and potted plant, grown in an area of 16.63 '000 ha (NHB 2014) .Occupies prominent place in vase decorations, bouquets and garland making. After green revolution, the indiscriminate use of chemical fertilizers has lead to negative impact on environment. To mitigate this, biostimulants have been emerged as a suppliment to mineral fertilizers and hold a promise to improve the yield as well as quality of the crop under protected condition (Rawat and Vishal, 2002). Keeping in view, the need and importance of biostimulants, the present investigation was conducted with an objective to study the effect of biostimulants on growth, yield, quality and economics of chrysanthemum under protected cultivation.

MATERIALS AND METHODS

The trial was taken up in chrysanthemum cultivar Kolar Local between 2015-16 at Department of Floriculture and Landscape Architecture, College of Horticulture, Mudigere. Healthy and uniform rooted terminal rooted cuttings of chrysanthemum were planted on the raised beds at a spacing of 30 cm X 30 cm under naturally ventilated polyhouse. The design adopted was Randomized Complete Block Design with 25 treatments and replicated two times. Treatments included T_1 – Control (RDF-100:150:100 Kg/ha), T_2 – Humigrow (Humic acid) @ 0.3%, T_3 – Humigrow @ 0.5%, T_4 – Fulvic acid @ 0.3%, T_5 – Fulvic acid @ 0.5%, T_6–Panchagavya @ 0.3%, T_7 – Panchagavya @ 0.5%, T_8–Jeevamruta @ 0.3%, T_9 – Jeevamruta @ 0.5%, T_{10} – Amruta Sanjeevini (lipoprotein + Humic acid) @ 0.3%, T_{11} – Amruta sanjeevini @ 0.5%, T_{12} – Zoom flower (Nitrobenzene) @ 0.3 %, T_{13} – Zoom flower @ 0.5%, T_{14} – Biovita (Sea Weed Extract) @ 0.3 %, T_{15} – Biovita @ 0.5%, T_{16} – Spicmex (Amino acid + Humic acid) @ 0.3%, T_{17} – Spicmex @ 0.5%, T_{18} – Neozyme @ 0.3%, T_{19} – Neozyme (Sea Weed Extract+ Amino Acid)@ 0.5%, T_{20} – Swara (Amino Acid, Nicotinic acid, Vit B_1,B_6,B_7) @ 0.3%, T_{21}- Swara @ 0.5%, T_{22} – Humicel plus (Humic Acid + Fulvic Acid+ Sea Weed Extract) @ 0.3%, T_{23} – Humicel plus @ 0.5%, T_{24} – Formula 15 (Humic Acid + Fulvic Acid + Amino acid) @ 0.3%, T_{25} – Formula 15 @ 0.5%. These biostimulants were sprayed on the foliage at 3 intervals *i.e* @ 60, 90 and 120 days after planting (DAP) and the observations like number of flowers per plant, flower yield per plant, flower yield per square meter, flower yield per hectare, sucker yield per plant, individual flower weight, flower diameter, stem length, vase life and shelf life, economics were recorded and the data were statistically analysed.

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RESULTS AND DISCUSSION

The effect of biostimulants on growth, yield and quality of chrysanthemum has exhibited significant differences (Table 1-3). With respect to the growth parameters Biovita @ 0.5 per cent registered maximum plant height (66.83 cm), Number of leaves (82.95) and stem diameter (7.30 mm) which was statistically on par with Humicel plus @ 0.5 per cent and Formula 15 @ 0.5 percent. However, minimum was recorded in control. The superiority in growth in sea weed extract sprayed plants is due to the presence of auxin and cytokinin precursors which results in enhanced cell division and cell elongation and the sea weed extracts are also involved in formation and maintenance of apical and axillary meristems promoting the growth.

Table 1. Influence of biostimulants on growth of chrysanthemum under naturally ventilated polyhouse

Treatment	Concentration (%)	Plant height (cm)	Number of leaves	Stem diameter (mm)
T_1 - Control (RDF)	100:150:100 Kg/ha	48.02	55.90	4.77
T_2 - Humigrow	0.3	56.58	68.10	6.27
T_3 - Humigrow	0.5	60.03	74.20	6.61
T_4 - Fulvic acid	0.3	55.33	66.30	6.20
T_5 - Fulvic acid	0.5	59.68	70.90	6.43
T_6 - Panchagavya	0.3	49.95	57.15	5.24
T_7 - Panchagavya	0.5	52.17	60.70	5.49
T_8 - Jeevamruta	0.3	52.39	58.15	5.30
T_9 - Jeevamruta	0.5	55.55	62.10	5.50
T_{10} - Amruta sanjeevini	0.3	50.94	58.05	5.35
T_{11} - Amruta sanjeevini	0.5	53.24	61.50	5.55
T_{12} - Zoom flower	0.3	52.89	59.25	5.50
T_{13} - Zoom flower	0.5	54.57	62.55	5.90
T_{14} - Biovita	0.3	61.51	75.85	6.78
T_{15} - Biovita	0.5	66.83	82.95	7.30
T_{16} - Spicmex	0.3	50.38	57.45	5.11
T_{17} - Spicmex	0.5	52.88	61.30	5.32
T_{18} - Neozyme	0.3	54.56	64.60	5.83
T_{19} - Neozyme	0.5	58.69	66.70	6.10
T_{20} - Swara	0.3	55.00	65.20	6.17
T_{21} - Swara	0.5	59.05	67.40	6.35
T_{22} - Humicel plus	0.3	60.94	73.31	6.74
T_{23} - Humicel plus	0.5	64.68	80.55	7.13
T_{24} - Formula15	0.3	60.75	73.02	6.65
T_{25} - Formula 15	0.5	63.88	78.90	7.07
S Em ±		1.55	1.70	0.13
C. D. (p=0.05)		4.52	4.95	0.39

*Note: RDF as a constant for all the treatments

Table 2. Influence of biostimulants on yield characters of chrysanthemum under naturally ventilated polyhouse

Treatment	Concentration (%)	Number of flowers/ plant	Flower yield per plant (g)	Flower yield per m^2 (Kg)	Flower yield per hectare (t)	Sucker yield per plant (no.)
T_1 - Control (RDF)	100:150:100 Kg/ha	60.00	201.3	1.87	18.7	5.45
T_2 - Humigrow	0.3	67.30	251.11	2.40	24.0	7.25
T_3 - Humigrow	0.5	75.30	305.80	2.95	29.5	8.35
T_4 - Fulvic acid	0.3	67.10	248.38	2.35	23.5	7.10
T_5 - Fulvic acid	0.5	73.45	290.57	2.78	27.8	8.00
T_6 - Panchagavya	0.3	62.50	203.15	1.92	19.2	6.00
T_7 - Panchagavya	0.5	65.75	230.31	2.17	21.7	6.65
T_8 - Jeevamruta	0.3	64.56	214.76	2.07	20.0	6.55
T_9 - Jeevamruta	0.5	67.50	236.25	2.26	22.6	7.10
T_{10} - Amruta sanjeevini	0.3	63.25	206.09	1.97	20.0	6.40
T_{11} - Amruta sanjeevini	0.5	66.25	228.82	2.18	21.8	6.95
T_{12} - Zoom flower	0.3	64.36	222.16	2.10	21.0	7.13
T_{13} - Zoom flower	0.5	69.40	248.24	2.32	2.32	7.58
T_{14} - Biovita	0.3	82.50	343.30	3.26	32.6	8.60
T_{15} - Biovita	0.5	92.15	424.09	4.05	40.5	9.85
T_{16} - Spicmex	0.3	63.00	204.07	1.95	19.5	6.33
T_{17} - Spicmex	0.5	66.15	231.53	2.11	21.1	6.77
T_{18} - Neozyme	0.3	63.40	220.30	2.05	20.1	6.85
T_{19} - Neozyme	0.5	68.65	251.24	2.25	22.5	7.32
T_{20} - Swara	0.3	64.70	229.61	2.16	21.6	7.11
T_{21} - Swara	0.5	72.70	268.56	2.40	24.0	7.74
T_{22} - Humicel plus	0.3	80.50	332.10	3.18	30.2	8.15
T_{23} - Humicel plus	0.5	91.15	405.68	3.90	39.0	9.59
T_{24} - Formula15	0.3	78.80	322.96	3.09	30.1	8.04
T_{25} - Formula 15	0.5	90.95	402.95	3.84	38.4	9.48
S Em ±		1.47	7.73	0.08	0.84	0.16
C. D. (p=0.05)		4.28	22.56	0.24	2.26	0.48

*Note: RDF as a constant for all the treatments

Table 3. Influence of biostimulants on quality parameters of chrysanthemum under naturally ventilated polyhouse

Treatment	Concentration (%)	Flower diameter (cm)	Individual flower weight (g)	Stem length (cm)	Vase life (days)	Shelf life (days)
T_1 - Control (RDF)	100:150:100 Kg/ha	4.19	3.50	34.21	15.00	5.50
T_2 - Humigrow	0.3	4.80	4.10	42.22	18.50	8.50
T_3 - Humigrow	0.5	5.26	4.60	44.91	21.00	9.50
T_4 - Fulvic acid	0.3	4.83	4.00	40.93	18.00	8.00
T_5 - Fulvic acid	0.5	5.19	4.45	43.67	19.50	9.00
T_6 - Panchagavya	0.3	4.70	3.65	36.52	16.00	6.50
T_7 - Panchagavya	0.5	4.99	3.87	38.76	17.50	7.00
T_8 - Jeevamruta	0.3	4.78	3.73	37.97	17.00	7.00
T_9 - Jeevamruta	0.5	5.20	3.96	40.06	18.00	7.50
T_{10} - Amruta sanjeevini	0.3	4.86	3.68	36.27	16.50	6.50
T_{11} - Amruta sanjeevini	0.5	5.01	3.94	38.04	17.50	7.00
T_{12} - Zoom flower	0.3	4.77	3.88	40.96	17.00	7.50
T_{13} - Zoom flower	0.5	5.05	4.20	41.98	18.50	8.00
T_{14} - Biovita	0.3	5.74	4.63	43.12	20.00	9.50
T_{15} - Biovita	0.5	6.70	5.06	46.89	22.50	11.00
T_{16} - Spicmex	0.3	4.62	3.71	36.65	19.50	6.50
T_{17} - Spicmex	0.5	4.98	3.90	37.85	21.50	7.50
T_{18} - Neozyme	0.3	5.02	3.88	41.09	17.50	7.00
T_{19} - Neozyme	0.5	5.30	4.25	43.15	18.50	8.00
T_{20} - Swara	0.3	5.05	4.04	42.11	18.00	7.50
T_{21} - Swara	0.5	5.39	4.39	44.21	19.50	8.50
T_{22} - Humicel plus	0.3	5.65	4.30	42.89	19.50	9.00
T_{23} - Humicel plus	0.5	6.60	4.89	46.35	21.50	10.50
T_{24} - Formula15	0.3	5.48	4.23	42.57	19.00	8.50
T_{25} - Formula 15	0.5	6.58	4.83	45.91	21.00	9.50
S Em ±		0.04	0.08	0.70	0.58	0.51
C. D. (p-0.05)		0.13	0.23	2.05	1.53	1.49

*Note: RDF as a constant for all the treatments

Table 4. Effect of biostimulants on cost economics of chrysanthemum for 560 m^2 under naturally ventilated polyhouse

Treatment	Concentration (%)	Total cost of production (₹)	Flower yield/560m^2 (Kg)	Sucker yield/ 560m^2 (No.)	Gross returns (₹) (Flowers and sucker)	Net returns (₹)	B:C ratio
T_1 - Control	100:150:100 Kg/ha	70, 226.93	1, 047.2	27, 468	1, 85, 836	1, 15, 609.07	1.64
T_2 - Humigrow	0.3	70, 326.93	1, 344.0	36, 540	2, 41, 080	1, 70, 753.07	2.42
T_3 - Humigrow	0.5	70, 326.93	1, 652.0	42, 084	2, 90, 668	2, 20, 341.07	3.13
T_4 - Fulvic acid	0.3	70, 423.93	1, 316.0	35, 784	2, 36, 068	1, 65, 644.07	2.35
T_5 - Fulvic acid	0.5	70, 423.93	1, 556.8	40, 320	2, 75, 240	2, 04, 816.07	2.90
T_6 - Panchagavya	0.3	70, 266.93	1, 075.2	30, 240	1, 94, 880	1, 24, 613.07	1.77
T_7 - Panchagavya	0.5	70, 266.93	1, 215.0	33, 516	2, 18, 907	1, 48, 640.07	2.11
T_8 - Jeevamruta	0.3	70, 276.93	1, 159.2	33, 012	2, 10, 924	1, 40, 647.07	2.00
T_9 - Jeevamruta	0.5	70, 276.93	1, 265.6	35, 784	2, 29, 776	1, 59, 499.07	2.26
T_{10} - Amruta sanjeevini	0.3	70, 301.93	1, 103.2	32, 256	2, 02, 412	1, 32, 110.07	1.87
T_{11} - Amruta sanjeevini	0.5	70, 301.93	1, 220.8	35, 028	2, 22, 656	1, 52, 354.07	2.16
T_{12} - Zoom flower	0.3	70, 376.93	1, 176.0	35, 935	2, 18, 870	1, 48, 493.07	2.10
T_{13} - Zoom flower	0.5	70, 376.93	1, 299.2	38, 203	2, 38, 806	1, 68, 429.07	2.39
T_{14} - Biovita	0.3	70, 376.93	1, 825.6	43, 344	3, 14, 888	2, 44, 511.07	3.47
T_{15} - Biovita	0.5	70, 376.93	2, 268.0	49, 644	3, 82, 788	3, 12, 411.07	4.43
T_{16} - Spicmex	0.3	70, 283.93	1, 092.0	31, 903	2, 00, 306	1, 30, 022.07	1.89
T_{17} - Spicmex	0.5	70, 283.93	1, 181.6	34, 120	2, 15, 940	1, 45, 656.07	2.07
T_{18} - Neozyme	0.3	70, 300.93	1, 148.0	34, 524	2, 12, 548	1, 42, 247.07	2.02
T_{19} - Neozyme	0.5	70, 300.93	1, 260.0	36, 892	2, 31, 284	1, 60, 983.07	2.28
T_{20} - Swara	0.3	70, 816.93	1, 209.6	35, 834.4	2, 22, 869	1, 52, 052.80	2.14
T_{21} - Swara	0.5	70, 816.93	1, 344.0	39, 009.6	2, 46, 019	1, 75, 202.07	2.47
T_{22} - Humicel plus	0.3	70, 351.93	1, 780.8	41, 076	3, 04, 752	2, 34, 400.07	3.33
T_{23} - Humicel plus	0.5	70, 351.93	2, 184.0	48, 333.6	3, 69, 667	2, 99, 315.27	4.25
T_{24} - Formula15	0.3	70, 326.93	1, 730.4	40, 521.6	2, 97, 343	2, 27, 016.07	3.22
T_{25} - Formula 15	0.5	70, 326.93	2, 150.4	47, 779.2	3, 64, 358	2, 94, 031.47	4.18

*Note: RDF as a constant for all the treatments

These results are in line with the findings of Rajarajan *et al.* (2014) in crossandra and Vivian *et al.* (2014) in marigold. Among yield parameters significantly highest number of flowers (92.15) flower yield per plant (424.09 g), flower yield per square meter (4.05 Kg), flower yield per hectare (40.50 t/ha), suckers per plant (9.85) were recorded in the treatment consisting of Biovita @ 0.5 per cent (Table 2). However, the above treatment was statistically on par with Humicel plus @ 0.5 per cent and Formula 15 @ 0.5 per cent. Whereas, control receiving only RDF (Recommended dose of fertilizers) recorded least with respect to all the above parameters. The increase in flower number might be due to significant increase in vegetative growth which produced more photosynthates which were probably diverted towards more flower production. The increase in number of flowers might be attributed by more number of leaves per plant and would have resulted in

production and accumulation of maximum photosynthates to the sink and their utilization for build up of new cells, thereby increasing the production of more number of flowers with bigger size. The similar results were reported by Dhutraj *et al*. (2003) in gaillardia. Improvement in yield over control may also be due to the greater availability of essential elements especially Nitrogen and phosphorous in sea weed extracts which is responsible for maximum shoot growth, more number of branches and hence ultimate size of the plant resulting in the production of higher photosynthesis, which subsequently led to desirable C: N ratio. These favourable situations led to production of more number of flowers and ultimately higher yield. The above results are supported by Khandelwal *et al.* (2003) in marigold, Shinde and Naik (2010) in marigold and Karthiraj *et al.* (2008) in China aster and Russo *et al.* (1994) in marigold.

Flower diameter, stem length and individual flower weight are the important parameters which decide the quality of the flower. Significant differences were observed among the different biostimulants for flower diameter, individual flower weight and stem length (Table 3). The longest flower stem, individual flower weight and flower diameter was observed in foliar application of Biovita @ 0.5 per cent (46.89 cm, 5.06 g and 6.70 cm, respectively) which was statistically on par with Humicel plus @ 0.5 per cent and Formula15 @ 0.5 per cent. These results were in accordance with Shinde and Naik (2003) and Karthiraj *et al*. (2008) who stated that the enlargement in size of the flower might be due to production of more food which was diverted to flowering area. The highest stem length was observed in sea weed extract sprayed plants as they are the precursors of auxin, cytokinin and micronutrients. In terms of vase life, foliar application of Biovita @ 0.5 per cent was found to be more effective and it had a maximum vase life of 22.5 days in normal tap water as compared to control (15.5 days). Similarly, the shelf life was found maximum in treatment comprising of Biovita @ 0.5 per cent (11 days) and minimum was found in control (5.5 days). The biostimulant induced photosynthesis that might have been led to recombination of nutrients in flower that is used for remaining long days in vase life. Entry of sea weed extract into the plant, which might have mediated the respiration by acting as an hydrogen acceptor and thus altering the carbohydrate metabolism of plants promoting the accumulation of sugar as inferred by Cacco and Dell'Agnola, (1984). Sea weed extract contain cytokinin and auxin that might have increased the antioxidant levels and resistance to senescence leading to enhanced longevity of stem. The economic analysis reveals that, foliar application of Biovita @ 0.5 per cent had resulted in the highest net return of 3, 12, 411.07 in 560 m^2 area with a B: C ratio of 4.43 followed by Humicel plus @ 0.5 per cent (2, 99, 315.27; 4.25, respectively) and Formula 15 @ 0.5 per cent (2, 94, 031.47; 4.18, respectively) compared to control (1, 15, 609.07; 1.64, respectively) (Table 4). The results are supported by Zawaneberg (1990) and Satapathy *et al*. (2015).

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